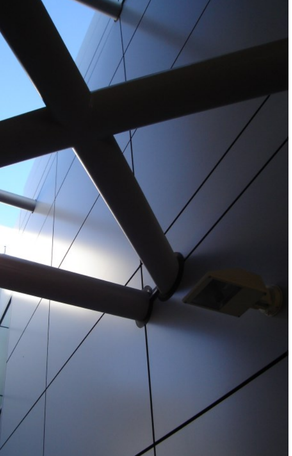

MECHANICAL ENGINEERING

*The Department of Mechanical Engineering presents:*

# *The Master's Dissertation Defense of:*

# *Stephen Exarhos*

## Monday, August 24, 2015
## 1PM, Bourns Hall A341

### Aerosol Spray Pyrolysis Synthesis of CZTS Nanostructures for Photovoltaic Applications

Master of Science, Graduate Program in Mechanical Engineering
University of California, Riverside, August 2015
Dr. Lorenzo Mangolini, Chairperson

As harmful effects caused by the extraction, purification, and combustion of natural resources for energy generation become more clearly understood, the need for economically competitive renewable energy becomes more desirable. Solar energy-generation is a technologically feasible method, though its primary drawback is cost. Traditional single-crystal silicon-based photovoltaics are too expensive to compete with nonrenewable energy generation, while alternative materials such as cadmium telluride and copper-indium-gallium-selenide contain expensive and unsustainable elements, while cadmium is a known carcinogen. Copper-zinc-tin-sulfide (CZTS) is an another alternative material, though the technology is not yet advanced enough to have reached the market.

The work presented is a study of the viability of synthesizing CZTS nanostructures using aerosol spray pyrolysis in an inexpensive, environmentally friendly, and industry-scalable way. We aerosolize a precursor solution with dissolved copper, zinc, and tin compounds and pass the droplets through a furnace, where the precursors dissolve and thermally form CZTS structures. Using this method, we can generate thin films — by placing a substrate within the furnace — and nanoparticles. While stoichiometric CZTS seems to be formed consistently, the films grown tend to be inhomogeneous in composition and morphologically unstable, yielding an inefficient material for two-dimensional photovoltaics. Nanoparticle synthesis seems to be the more appropriate application of spray pyrolysis with this material system. We have shown the ability to control the composition and doping of CZTS nanoparticles, and preliminary efforts in coating and sintering the nanoparticles into crystalline films are promising.